Flood Frequency Analysis in Context of Climate Change

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Some Observations on Living with Uncertainty

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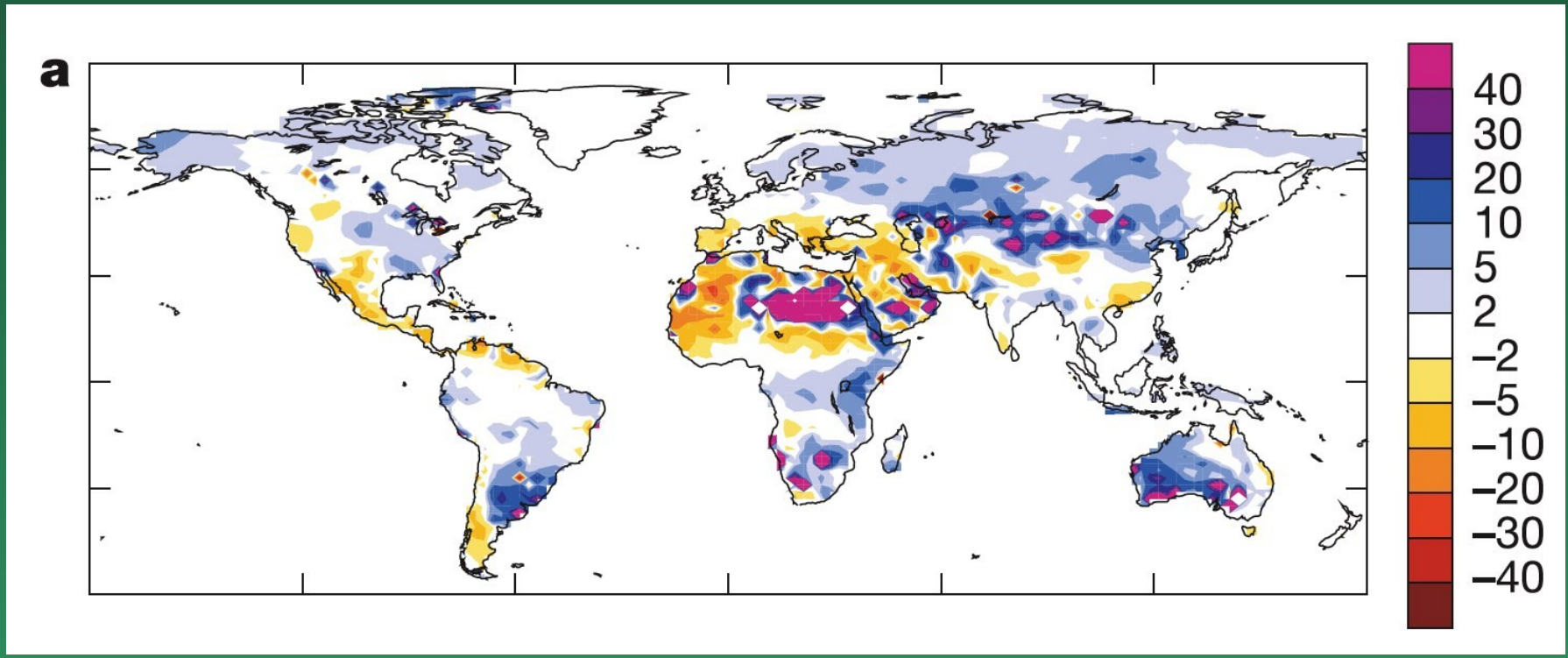
Changes in 20th Century Runoff

100*(mean[1971-1998]-mean[1900-1970])/mean[1900-1970]



Milly et al., 2005

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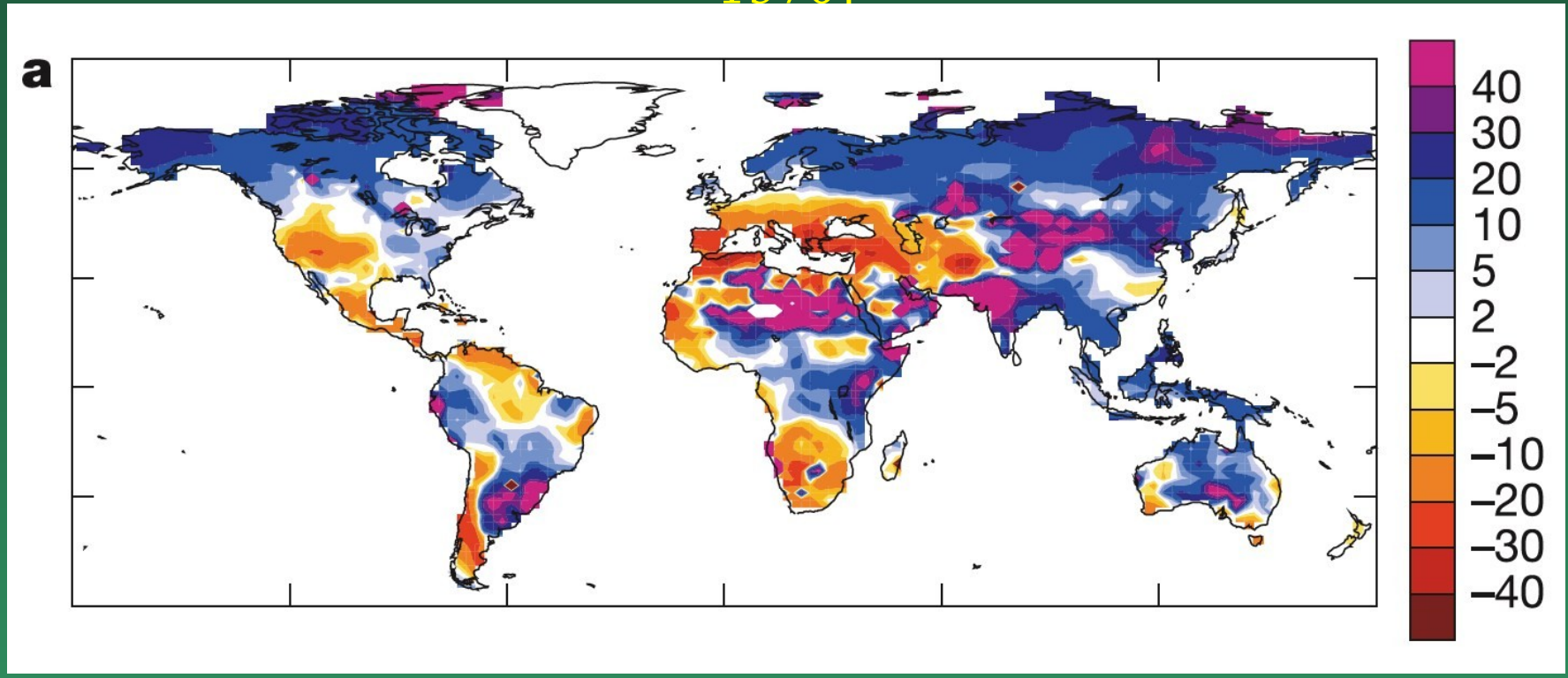
Projected Changes in 21st Century Runoff

100*(projected[2041-2060]-mean[1900-1970])/mean[1900-1970]



Milly et al., 2005

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Concern: What About Floods?

- Intuition (?):
  - Floods *should* increase
- Physics:
  - Substantial uncertainty about impact of climate change because processes associated with extreme floods are sensitive to timing, duration and magnitude of a combination of meteorological factors in addition to watershed and channel factors
- Data:
  - [Lins and Slack, 1999; Milly, 2002; Kundzewicz et al., 2005; Small et al., 2006;…]

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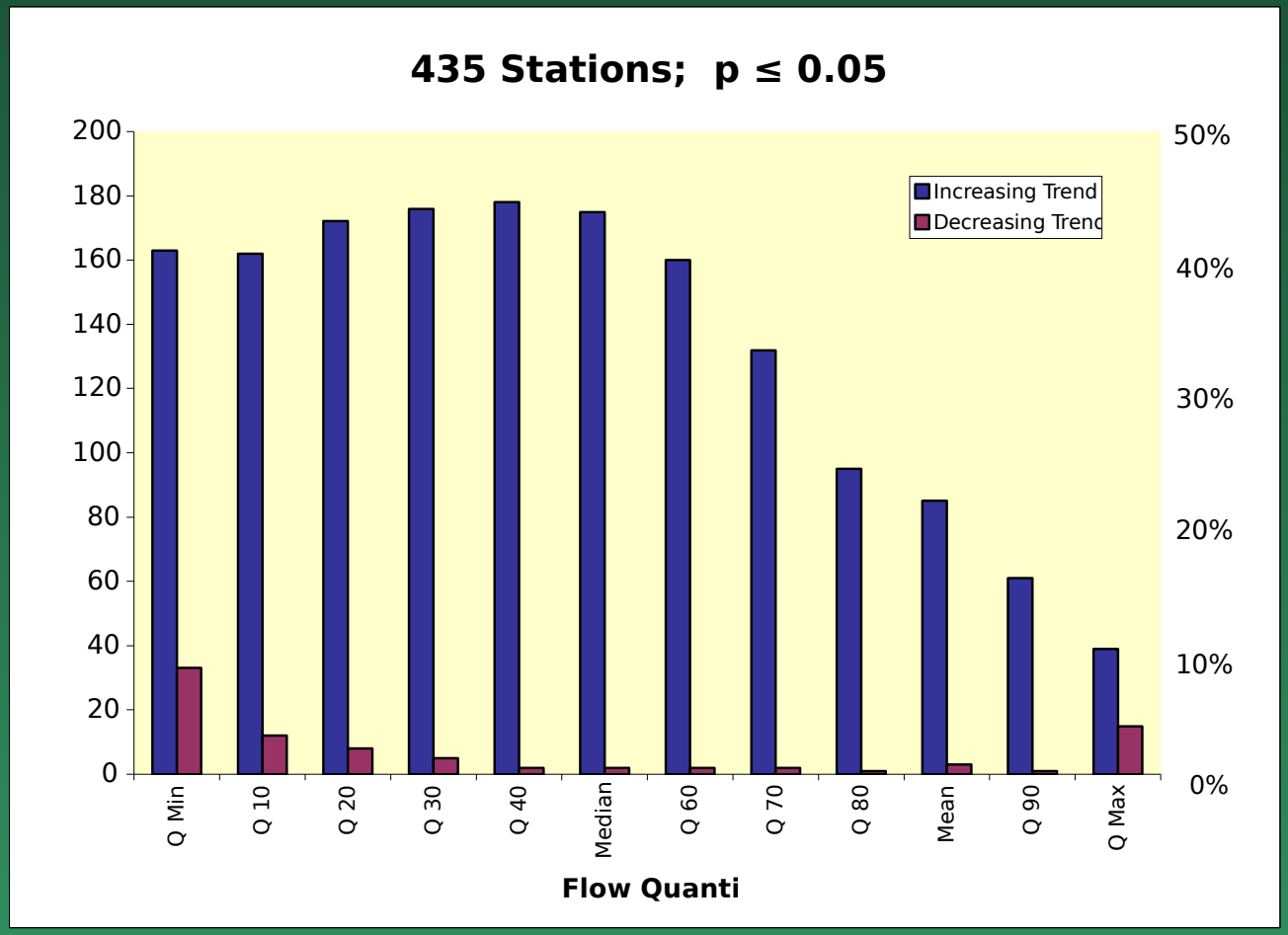
Trends in U.S. Streamflow, 1940-1999



Source: Updated from Lins and Slack, Geophys. Res. Lett., 26, p. 227

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Paradox: Given increases in precipitation and runoff, why are there so few significant trends in floods?

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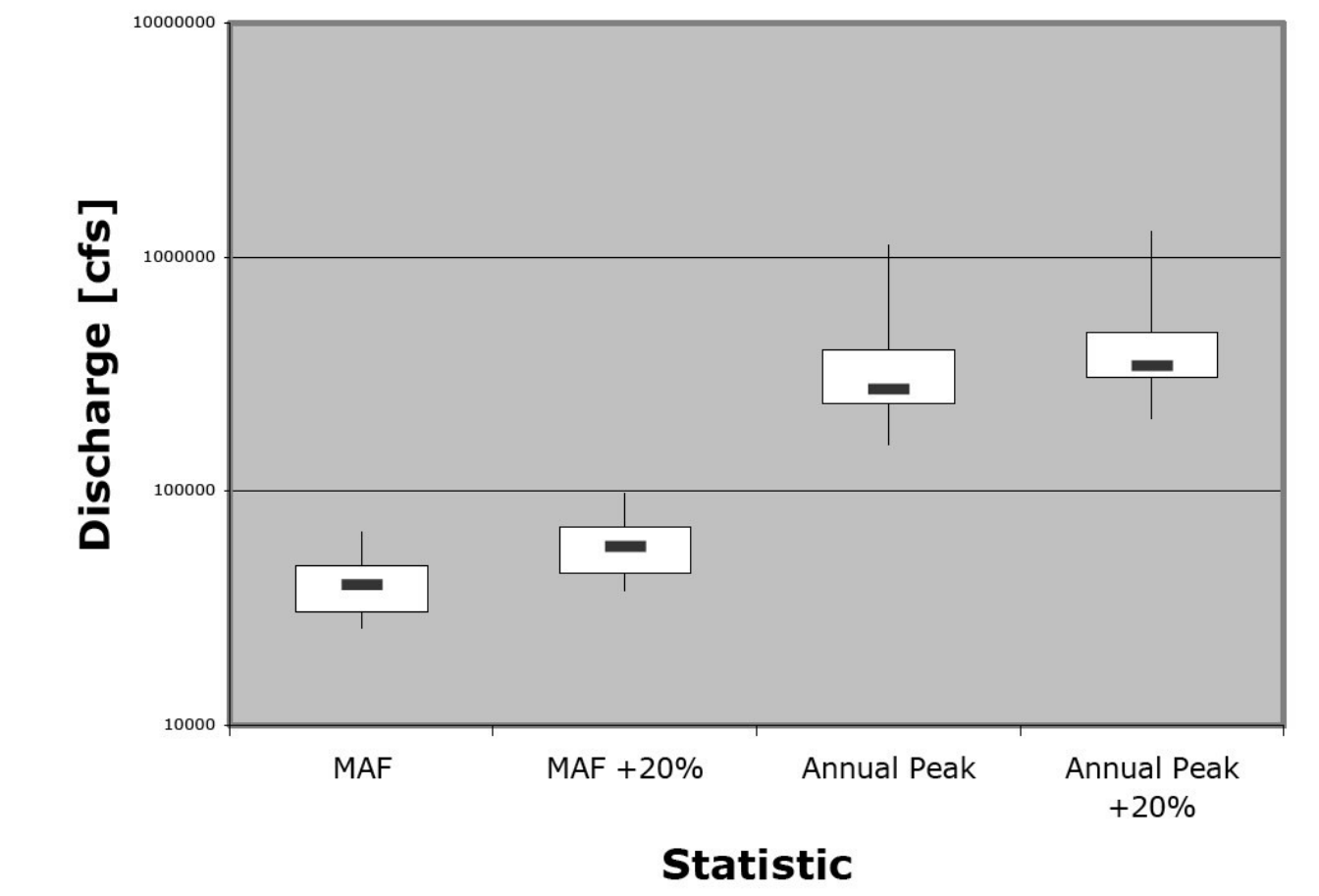
Explanation (?) (a)…



[Lins and Cohn, 2002]

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Explanation (?) (b)…

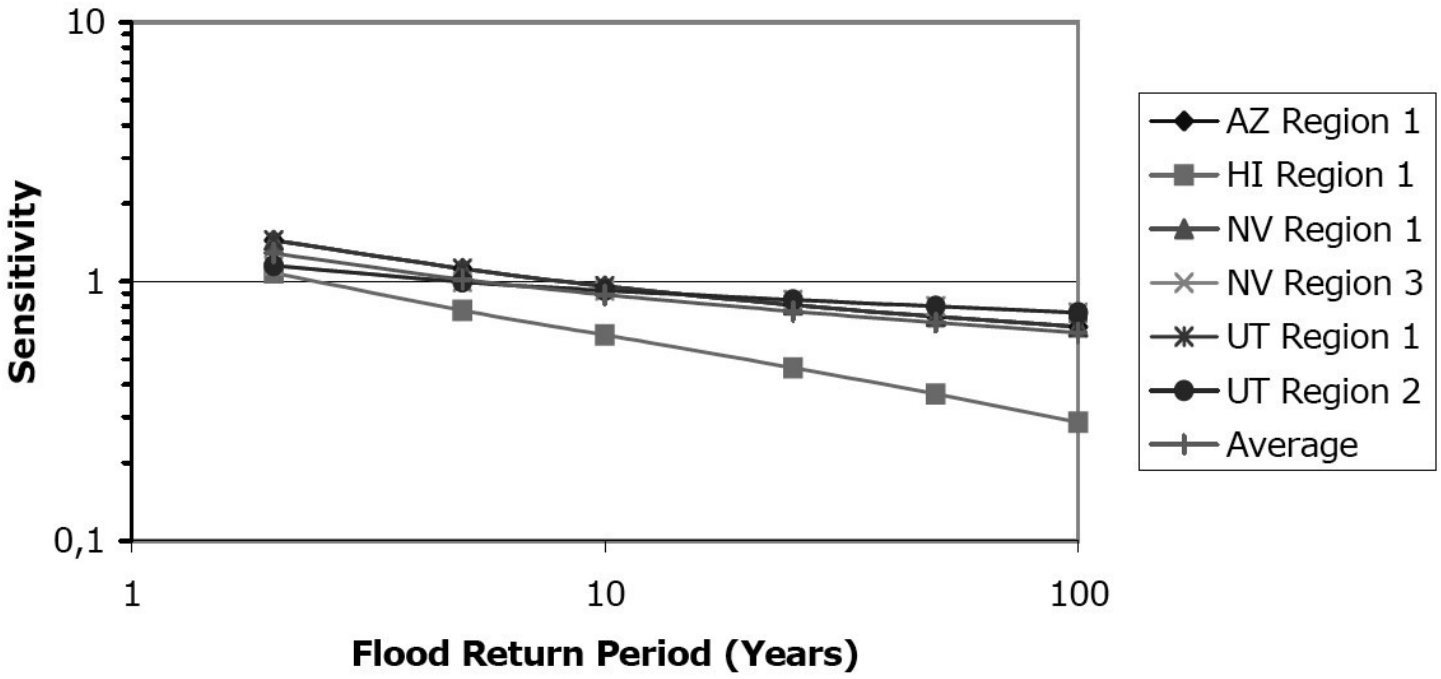

Figure 1. Sensitivity (elasticity) of flood flows at various return periods to mean annual precipitation.

[Lins and Cohn, 2002]

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Other Sources of Uncertainty

- Land-use changes
  - Urbanization
  - De/Re Forestation
- Sampling variability
- Correlation
  - Spatial (across sites)
  - Temporal (long-term persistence)

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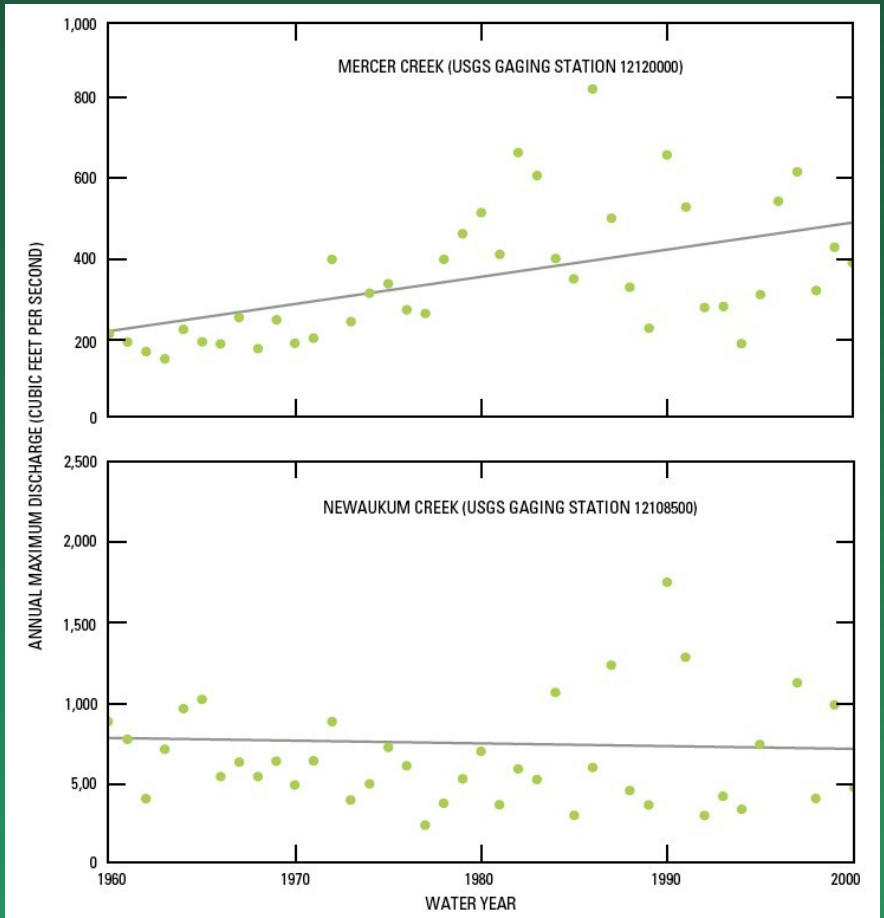
Impact of Development



Annual maximum discharge increased with urban development in Mercer Creek from 1960 to 2000, but remained essentially the same in nearby rural Newaukum Creek during that period.

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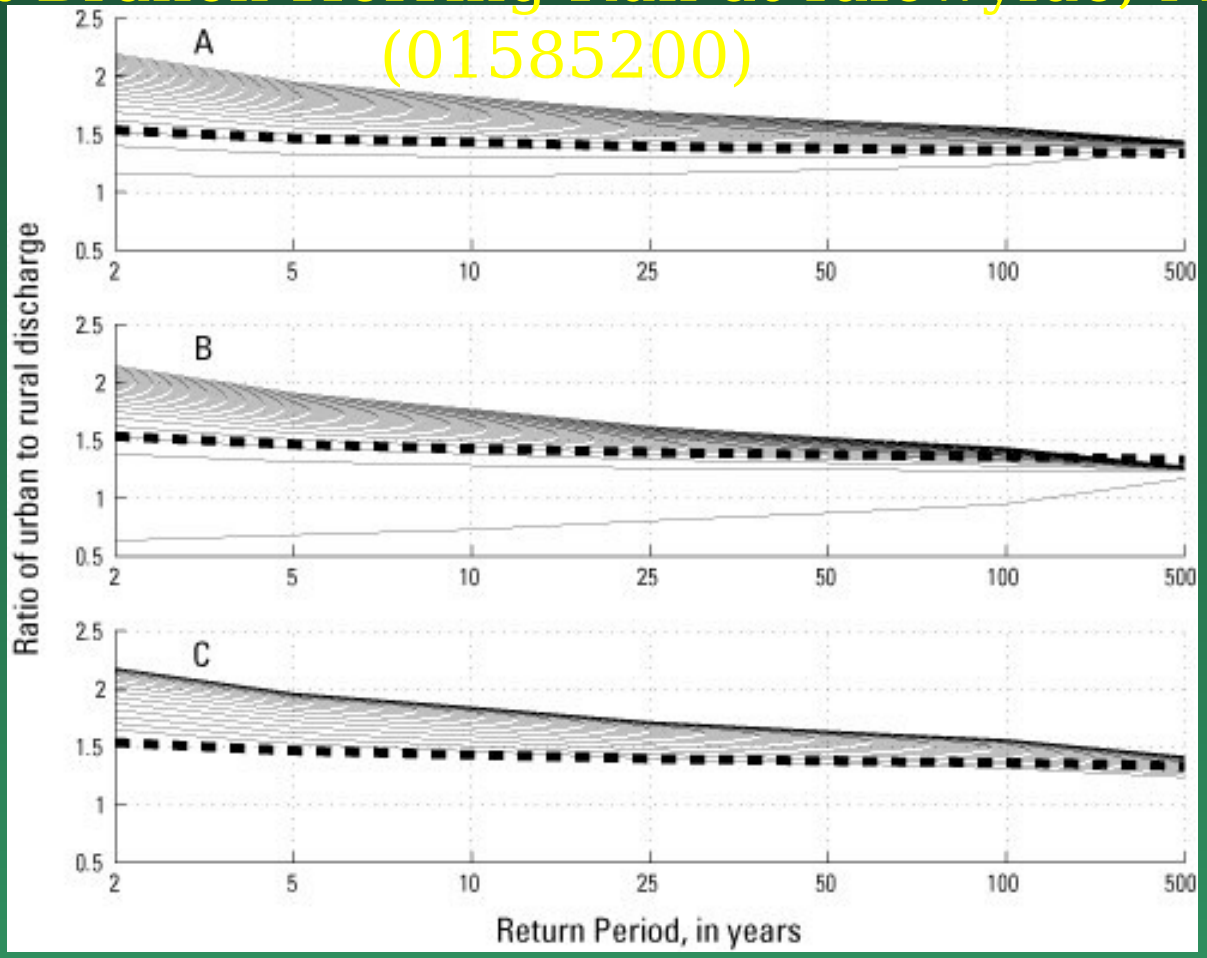
[Konrad,2003]

Ratio of Urban to Rural Discharge

West Branch Herring Run at Idlewylde, MD (01585200)



[Moglen and Shivers, USGS SIR 2006-5270]

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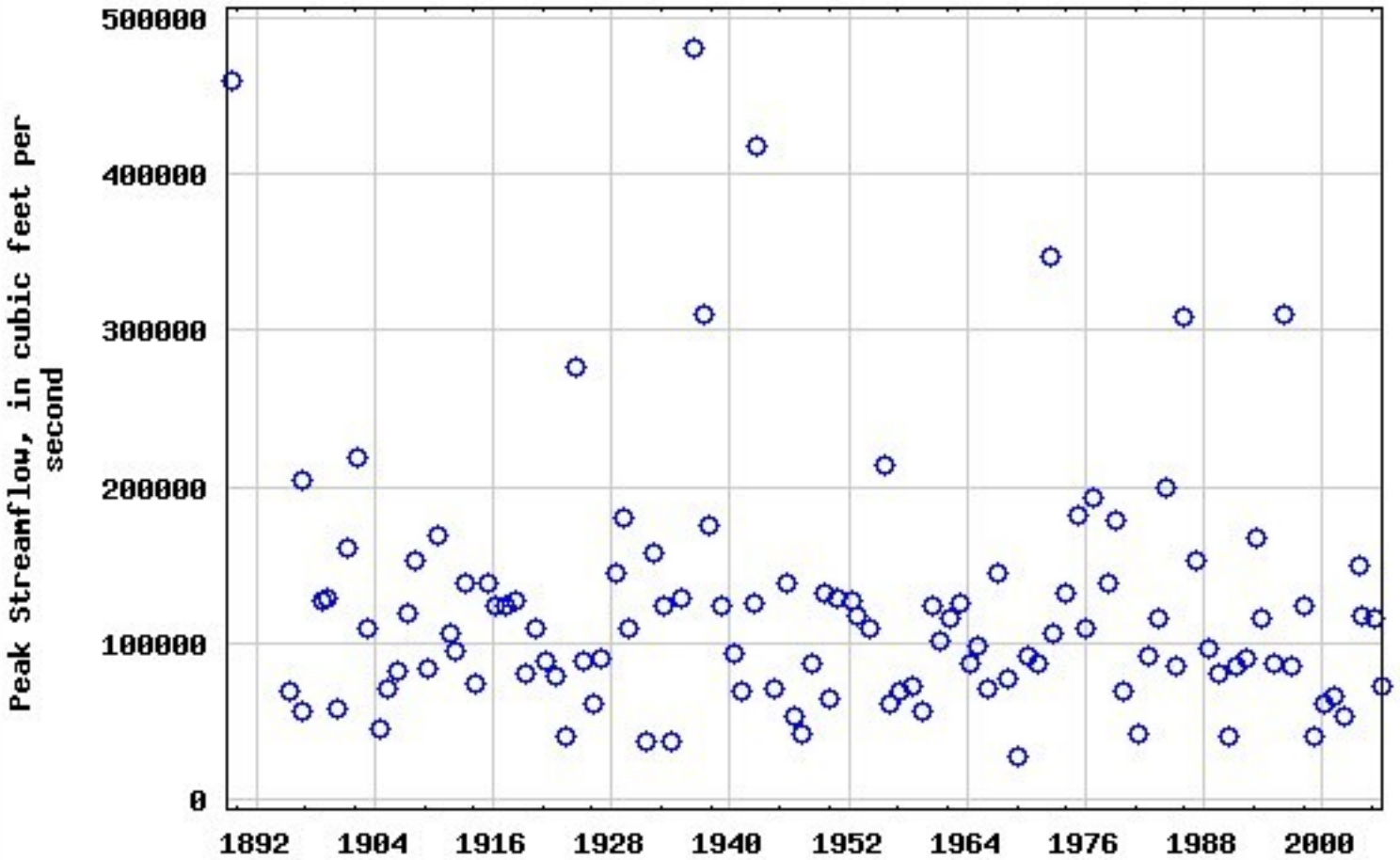
USGS 01638500 POTOMAC RIVER AT POINT OF ROCKS, MD



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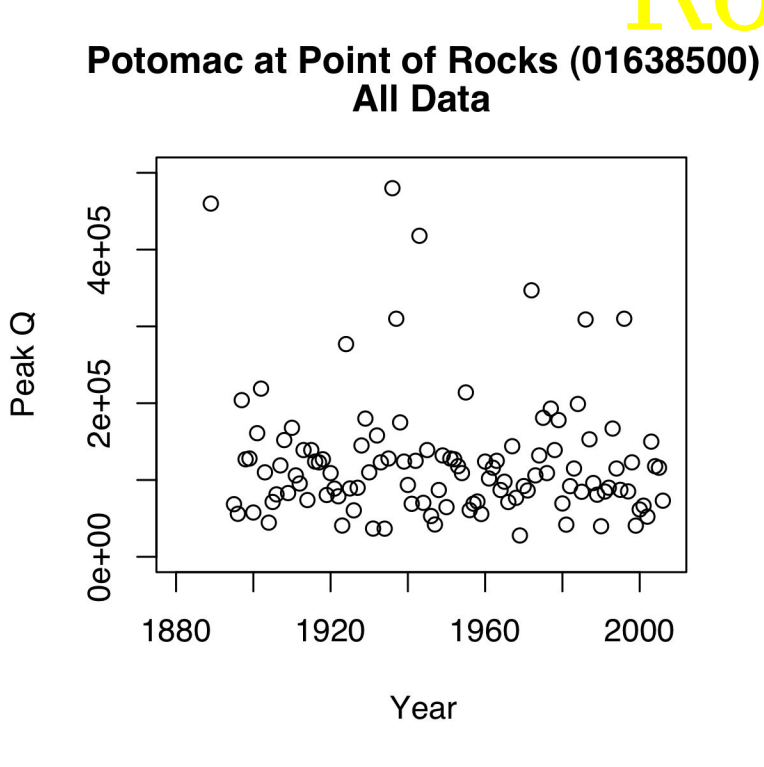
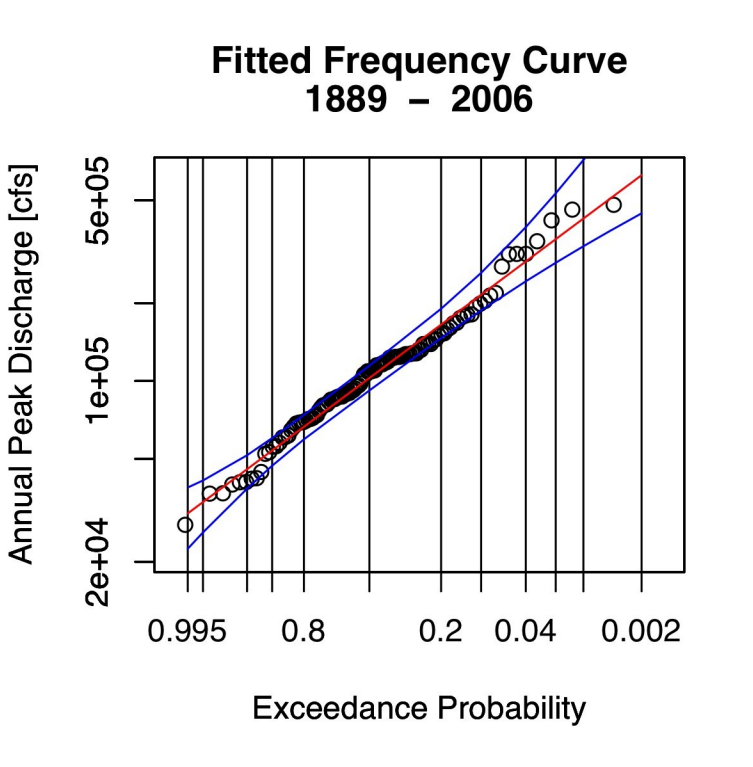
1% Flood at Point of Rocks





Estimated $Q_{0.99}$ = 425,000 [cfs]

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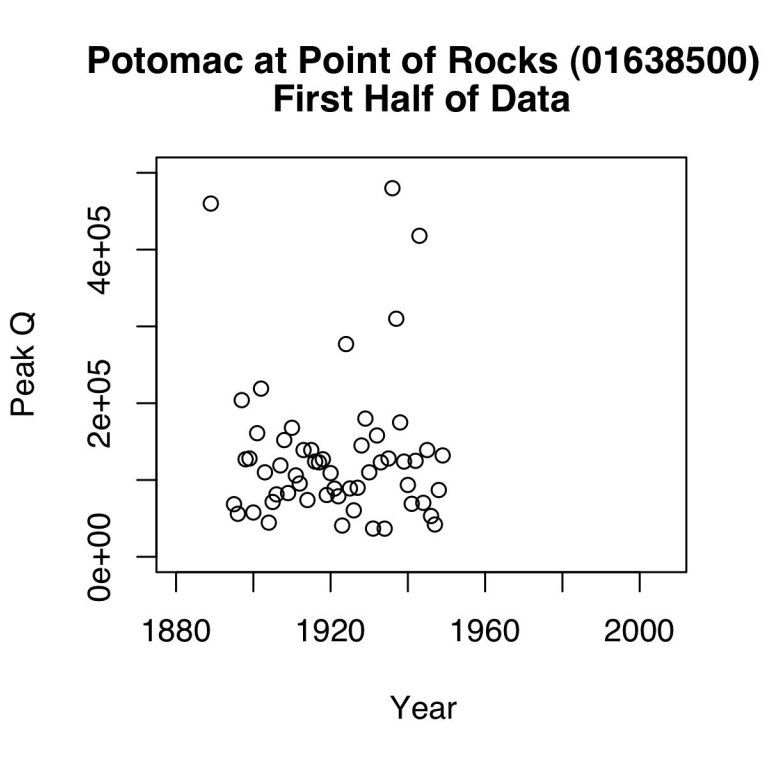
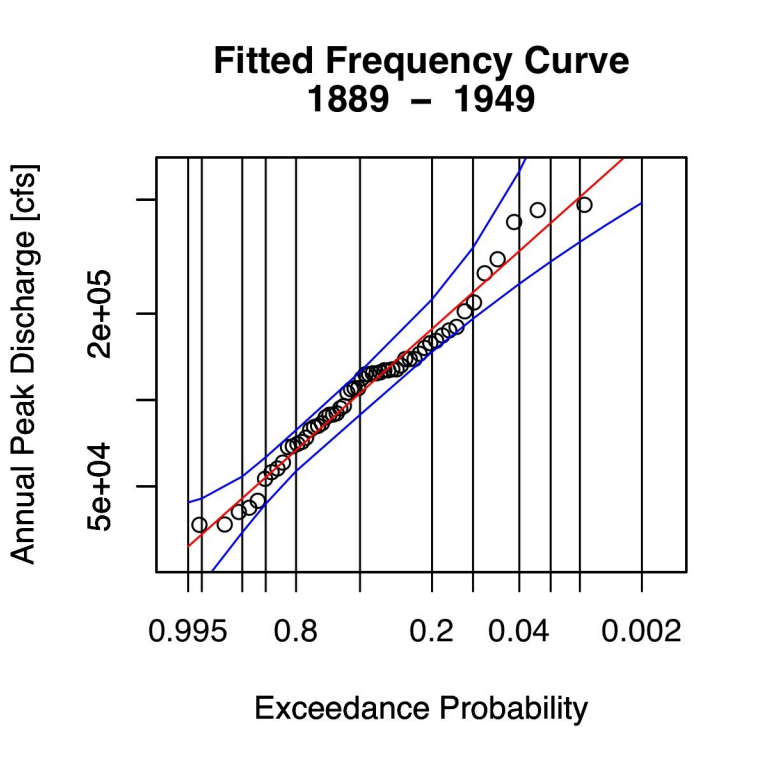
1% Flood at Point of Rocks





Estimated $Q_{0.99}$ = 511,000 [cfs]

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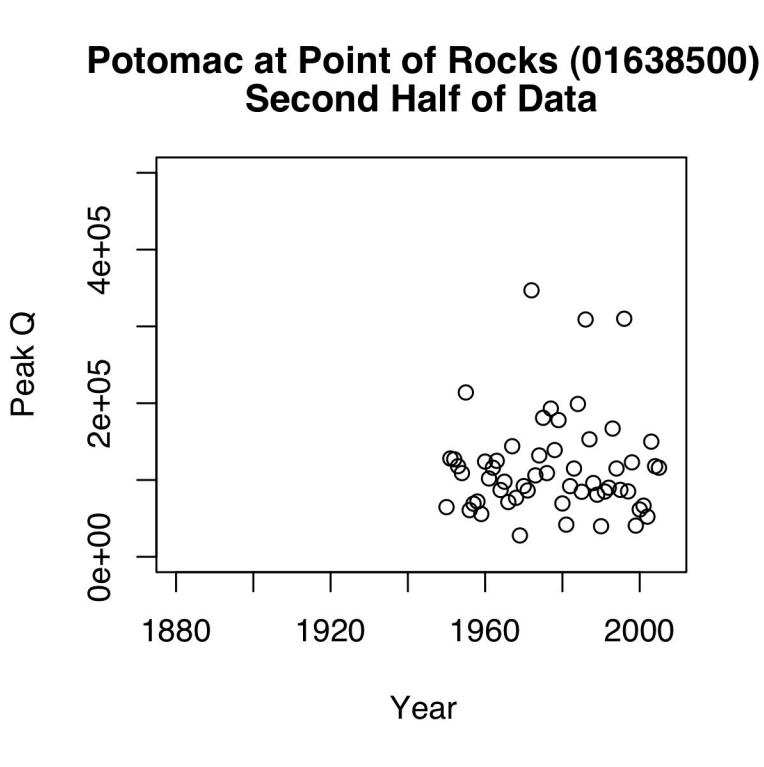
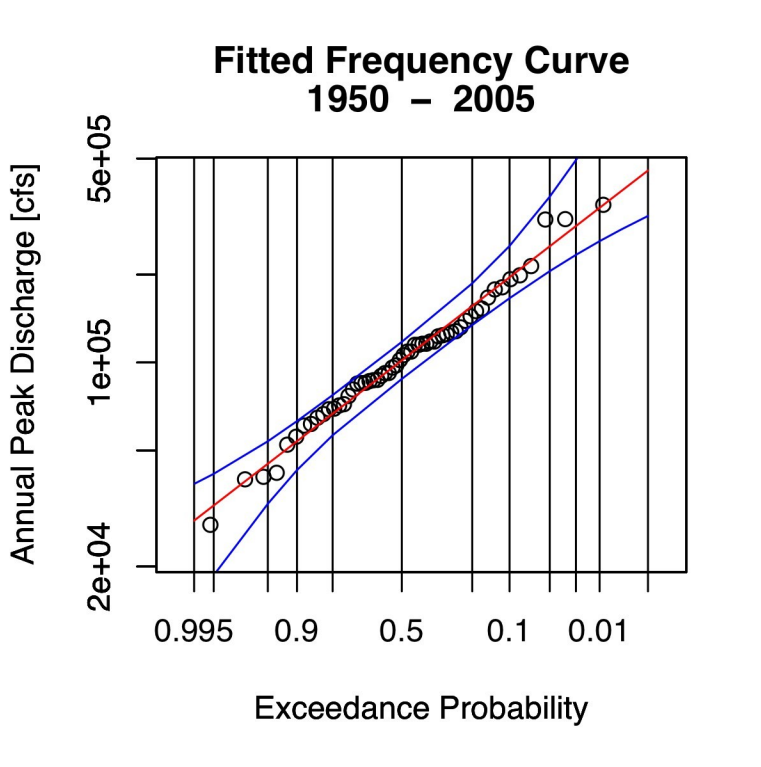
1% Flood at Point of Rocks





Estimated $Q_{0.99}$ = 339,000 [cfs]

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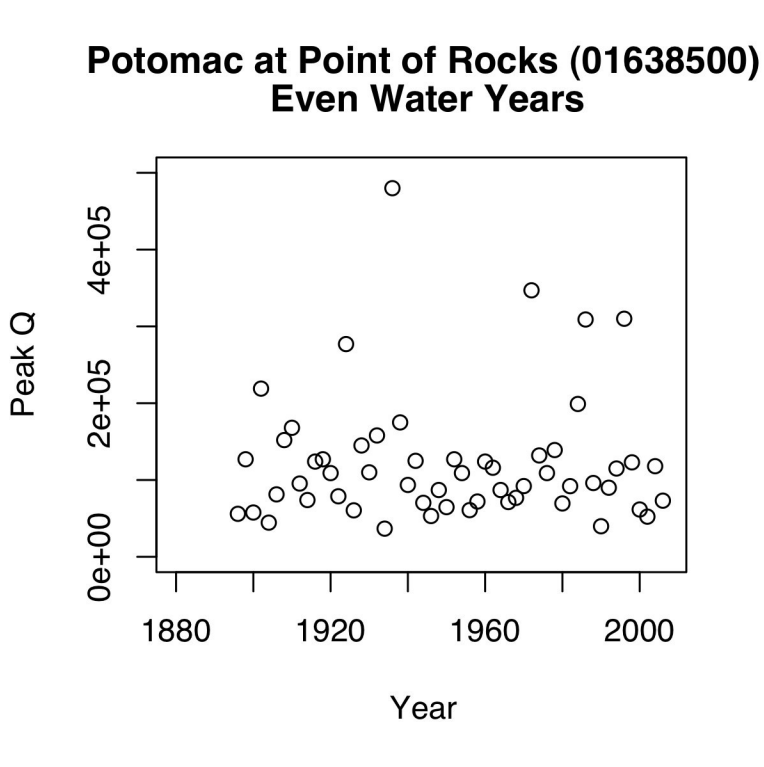
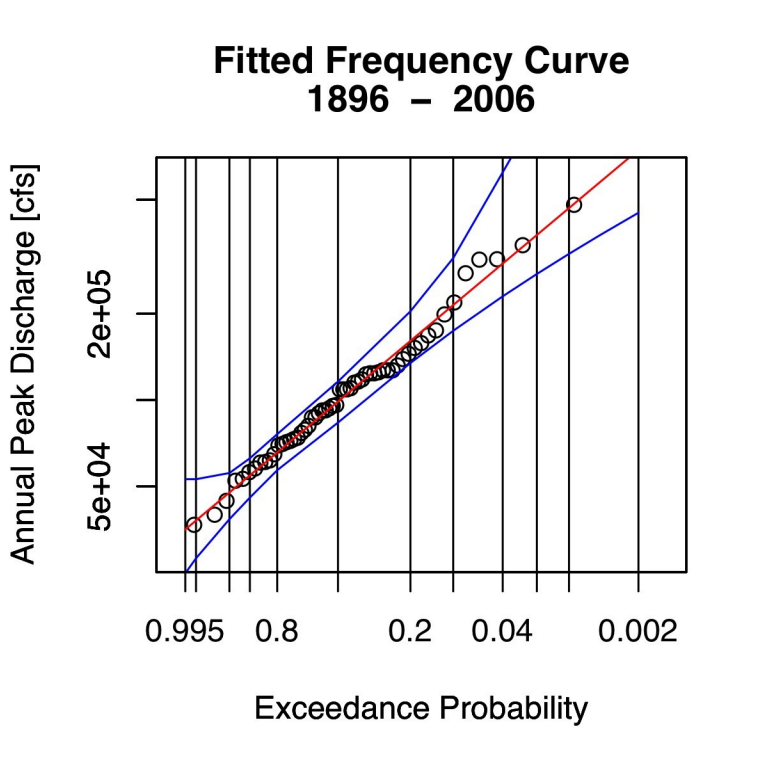
1% Flood at Point of Rocks





Estimated $Q_{0.99}$ = 467,000 [cfs]

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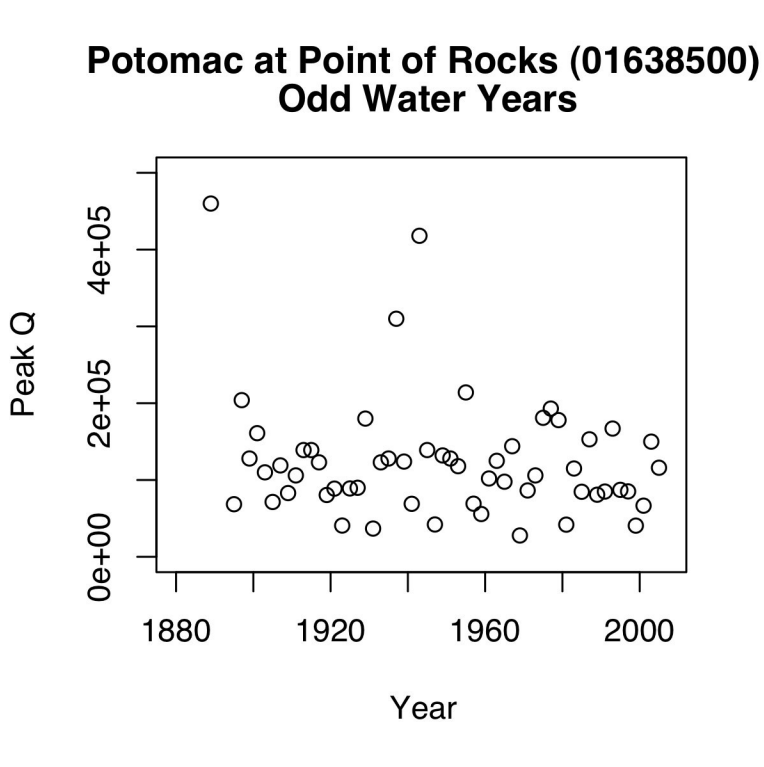
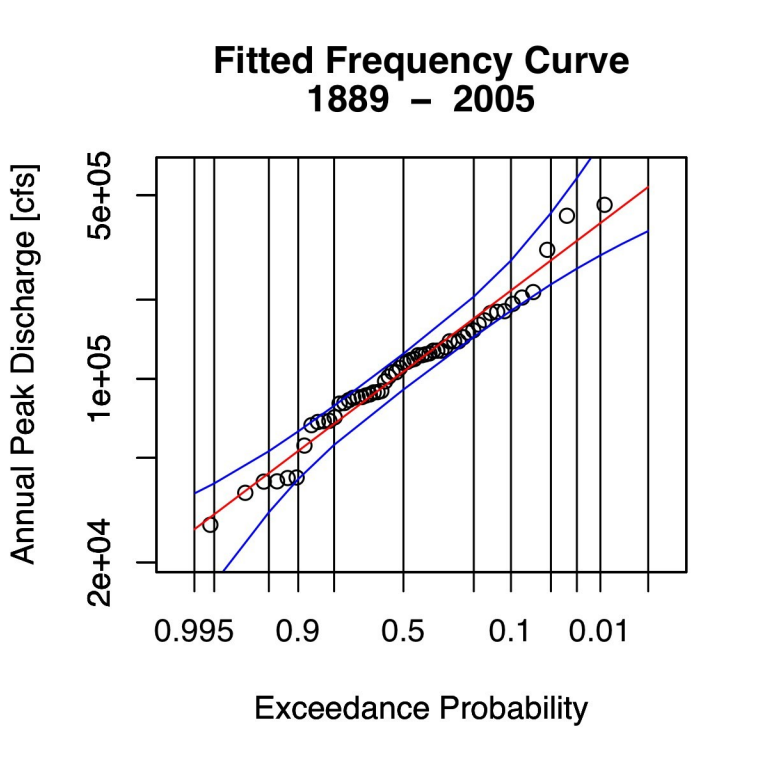
1% Flood at Point of Rocks





Estimated $Q_{0.99}$ = 392,000 [cfs]

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Flood Frequency Estimates

Data	N	$Q_{0.99}$	LowerCI	Upper C
All	113	425,000	332,000	715,000
First	57	511,000	356,000	1,570,000
Second	56	339,000	260,000	653,000
Odd	57	392,000	295,000	781,000
Even	56	467,000	324,000	1,550,000

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Two Problems

- Scientific
  - Characterizing flood processes
  - Describing uncertainties
- Operational
  - Consistency
  - Sharp lines that distinguish cases

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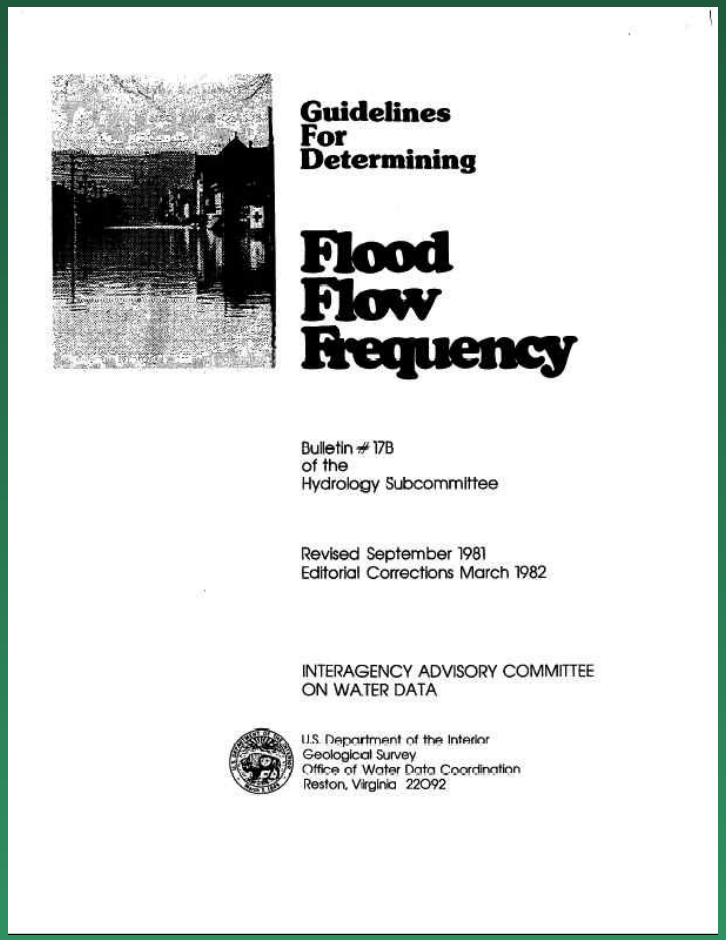
Bulletin 17B



History:

- 1967 Bulletin 15
- 1976 Bulletin 17
- 1977 Bulletin 17A
- 1981 Bulletin 17B

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Bulletin 17B "Data Assumptions"

A. Climatic Trends

There is much speculation about climatic changes. Available evidence indicates that major changes occur on time scales involving thousands of year. In hydrologic analysis it is conventional to assume that flood flows are not affected by climatic trends or cycles.

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Conclusions

- The impact of climate change on flood frequency is not obvious
- Existing sources of uncertainty, including natural variability and land-use changes, are likely to obscure changes related to climate change
- Operational decisions will be made in the context of increased uncertainty

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Thank You!

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